PERSONALIZED SYSTEM OF INSTRUCTION IN CYBERSPACE

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Four different undergraduate psychology courses with no allotted classroom time slots were taught in the same term by means of a computer-based version of Keller's personalized system of instruction (PSI), called computer-aided personalized system of instruction (CAPSI). Students' performance and ratings indicate that CAPSI is a viable on-line educational method.

DESCRIPTORS: personalized system of instruction, proctors, computer-mediated learning, university students

Keller's (1968) personalized system of instruction (PSI) is a powerful teaching method, yet it generally requires many hours to administer. In recent years, several computer-based versions of PSI have been described (e.g., Crosbie & Kelly, 1993). We report the extension of a method called the computer-aided personalized system of instruction (CAPSI; Pear & Kinsner, 1988; Pear & Novak, 1996) to a "cyberspace" environment, that is, a situation in which there is no classroom or regularly scheduled classes.

METHOD

Participants

Ninety-one students enrolled in and 60 completed four undergraduate second-year courses (3 semester credit hours each) taught by the first author during the fall term of 1997 at the University of Manitoba: Behavior Modification: Principles (B. Mod. I; $n = 20$), Behavior Modification: Applications (B. Mod. II; $n = 12$), Learning Foundations of Psychology (Learning; $n = 15$), and Orientations to Psychological Systems (Systems; $n = 13$). All four courses ran concurrently during the approximately 13-week term.

Software, Hardware, and Materials

CAPSI/PC© (D. G. M. Consulting Inc.) was installed on a Novell server in the Department of Psychology. A local area network (LAN) provided campus-wide access to the program from PC computer laboratories open 24 hr per day, 7 days per week, and a host computer was available for remote access by students who had the necessary software and hardware (i.e., pcANYWHERE© [Semantec], a modem, and an IBM PC or PC-clone computer). The chief functions of the CAPSI/PC program were to (a) deliver the unit tests and the midterm and final examinations, (b) assign short essay-type completed unit tests and examinations to markers, and (c) keep track of all course data.

In addition to the course textbooks, course manuals containing the study questions for the course, a guide to answering essay-type questions, information for contacting the instructor (i.e., the instructor's phone numbers, his university office room

number, and his E-mail address), and instructions for following the course procedures and using the CAPSI program were available at the campus bookstore.

Course Procedures

The course procedures were similar to those described elsewhere (e.g., Pear & Novak, 1996), the major differences being the use of a PC version rather than a mainframe version of the CAPSI program and the fact that there were no class meetings.

Students earned points toward their final grade in a given course by passing up to 10 unit tests (1 point per passed unit), serving as proctors (i.e., markers) for other students' unit tests (½ point per occurrence; see below), and completing two midterm examinations (up to 15 points each) and a final examination (up to 60 points). Students had the option of writing a term paper in place of proctoring, but only 2 students chose that option. Unit tests, composed of short-answer essay questions (e.g., from B. Mod. I: "What is another name for shaping? List four aspects of behavior that can be shaped. Give two examples of each."), were marked on a mastery basis. The final examination was weighted heavily relative to the other portions of the course because it was the only directly supervised portion of the course.

The CAPSI program delivered requested unit tests (three randomly assigned study questions per unit) and (when scheduled) the midterm and final examinations. Prior to submitting a unit test, a student could opt to cancel it and attempt a new test on the unit following a minimum 1-hr "restudy" time. The program assigned submitted unit tests for marking to two available proctors, who were students in the course who had previously passed the unit to be marked and had signed on to be proctors, or (if there were no available proctors) to the teaching assistant or the course instructor. Students indicated a willingness to proctor by chang-

ing a setting in their accounts and specifying dates and times on which they were available to proctor. When there were more than two available proctors for a given unit test, the program assigned the test to the two proctors with the fewest proctor points, or randomly to two available proctors with the fewest proctor points if there were more than two. Students did not know to which proctors their unit tests would go nor did proctors know whose unit tests they were marking. A proctor who did not mark an assigned test within 24 hr received a ½ point penalty, and the test was submitted to another marker. In order for a unit test to receive a pass, it had to be passed by the instructor, the teaching assistant, or *both* proctors it was submitted to. If a student received a restudy result on a unit test, he or she could (a) write another unit test after at least 1 hr following the restudy result or (b) appeal the result to the instructor by pressing a specific function key and providing a valid argument for why his or her answer was correct. The program assigned all midterm and final examinations to the course instructor for marking.

Feedback was usually provided to students on their unit tests within 24 hr following submission. The program provided a window for markers to write detailed feedback immediately below the test answer (see Figure 1). Thus, markers did not merely assign "pass" or "restudy" results, but also provided written feedback. Proctors viewed only the tests they marked; however, after the test was marked, the test writer could view the feedback from both proctors. In addition, the instructor's written decision on appealed restudy results was E-mailed automatically to the student who appealed the decision and to both proctors who marked the test so that all 3 students would benefit from that information.

Occasionally problems with the system (e.g., server down) resulted in penalties because of late submission of proctoring, unit

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══════════════════ Question # 1 ══════════════════
┌─────────────────────────────────────────────────┐
│Question (4435)                                   │
│Give and explain an example of stimulus control.  │
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│                                                  │
│                                                  │
│                                                  │
└─────────────────────────────────────────────────┘
 Answer
┌─────────────────────────────────────────────────┐
│A stimulus control is when a specific stimulus is present│
│when a particular response is reinforced, and not present│
│when the response is not reinforced.  The response will  │
│occur more frequently when the stimulus is present, rather│
│than when the stimulus is absent.  An example would be that│
└─────────────────────────────────────────────────┘
 Comments
┌─────────────────────────────────────────────────┐
│Excellent answer, with a very good example!  Keep up the│
│good work!!                                       │
│                                                  │
│                                                  │
│                                                  │
└─────────────────────────────────────────────────┘
═════════════ F1-Question  F2-Answer ═════════════
═══════════════════ Test #2 ══════════════════════
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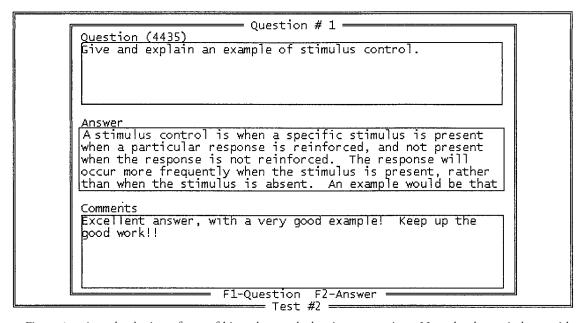
Figure 1. A student's view of one of his or her marked unit test questions. Note the three windows, with the question in the top window, the student's answer in the middle window, and the marker's comments on the answer in the bottom window. Within each window, the student can scroll to read text below the field of view.

tests, and midterm examinations. These penalties were easily removed by the instructor using the editing functions of the CAPSI/PC program.

RESULTS AND DISCUSSION

Table 1 shows the percentage and number of students who completed each course (defined as writing the final examination) on time, received time extensions, or voluntarily withdrew from the course after demonstrating either some measurable work (defined as passing at least one unit test or completing at least one midterm examination) or no measurable work in the courses. Although 32% of the students voluntarily withdrew from the courses, the majority of these evidently did so without sampling the CAPSI program. The remainder of this report is concerned only with those students who did not withdraw.

As shown in Table 2, except in the Learning course, the majority of students completed all 10 units. In addition, 80% proctored at least one unit test, and 62% proctored at least 10 unit tests. Students in the

Table 1
Summary of Student Course Participation

Course	N	% completed course	% granted extension	% VW with work	% VW without work
B. Mod I	33	60.61 ($n = 20$)	3.03 ($n = 1$)	3.03 ($n = 1$)	33.33 ($n = 11$)
B. Mod II	12	100.00 ($n = 12$)	0.00 ($n = 0$)	0.00 ($n = 0$)	0.00 ($n = 0$)
Learning	31	48.39 ($n = 15$)	3.23 ($n = 1$)	6.45 ($n = 2$)	41.84 ($n = 13$)
Systems	15	86.67 ($n = 13$)	0.00 ($n = 0$)	3.03 ($n = 1$)	13.33 ($n = 2$)
Total	91	65.94 ($n = 60$)	2.20 ($n = 2$)	3.30 ($n = 3$)	28.57 ($n = 26$)

Note. VW = voluntarily withdrew.

Table 2
Summary of Student Test Completion and Proctoring

Course	N	% completed at least one unit test	% completed at least four unit tests	% completed at least seven unit tests	% completed ten unit tests	% proctored at least one unit test	% proctored at least ten unit tests
B. Mod I	20	100.00 ($n = 20$)	95.00 ($n = 19$)	80.00 ($n = 16$)	65.00 ($n = 13$)	85.00 ($n = 17$)	75.00 ($n = 15$)
B. Mod II	12	91.70 ($n = 11$)	91.70 ($n = 11$)	83.33 ($n = 10$)	75.00 ($n = 9$)	91.67 ($n = 11$)	66.67 ($n = 8$)
Learning	15	100.00 ($n = 15$)	60.00 ($n = 9$)	53.33 ($n = 8$)	20.00 ($n = 3$)	73.33 ($n = 11$)	46.67 ($n = 7$)
Systems	13	92.31 ($n = 12$)	76.92 ($n = 10$)	69.23 ($n = 9$)	61.54 ($n = 8$)	69.23 ($n = 9$)	53.85 ($n = 7$)
Total	60	96.67 ($n = 58$)	81.67 ($n = 49$)	71.67 ($n = 43$)	55.00 ($n = 33$)	80.00 ($n = 48$)	61.67 ($n = 37$)

Learning course probably proctored fewer unit tests because a smaller number of tests were written in that course. There are several possible reasons for the fact that the Learning course was an outlier, including the conceptual difficulty of the material (Machado & Silva, 1998).

The mean scores on both midterm examinations were similar across all courses ($M = 86\%$). The average final examination marks were somewhat lower ($M = 71\%$) than the midterm examination marks, perhaps because the final covered more course material and was supervised.

On a departmental student evaluation questionnaire administered at the end of the term, the majority of students (53.7%) reported that the CAPSI-taught courses were good or very good compared with other courses; a further 37.0% reported that the courses were average. It therefore appears that the majority of students (90.7%) were reasonably satisfied with the courses; that is, consumer satisfaction was high.

Although there were clear differences in student performance (especially between Learning and the other courses), all four courses were successful according to the admittedly loose criteria by which courses are generally considered to be successful at the college level. The majority of students who enrolled in each course completed enough of the coursework and demonstrated sufficient proficiency with the material to receive at least an average grade and to report general satisfaction with the course.

Although the present data are preliminary, there is reason to believe that this teaching method is highly efficient because of the two major ways in which it makes use of available human and computer resources. First, by utilizing students who have completed specific unit tests as proctors for those units, CAPSI capitalizes on the human resources within a course. This increases the number of students that one instructor can teach in a given course without resorting to techniques such as multiple-choice tests. Moreover, students appear to benefit from serving as proctors. When asked whether they felt that proctoring "helped me learn the material," 71% of students agreed that it did (5% disagreed and 24% were neutral). Second, the utilization of computer networking removes the need for the instructor to be physically present in a classroom, which allows an instructor to increase his or her efficiency by, for example, teaching several small-enrollment courses with no greater time expenditure than would be required by one large-enrollment class. In addition, the teaching method described in this report provides a

link between educational technology and computer technology and serves as a valuable research tool for studying the educational process.

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